

CLAIMS

What is claimed is:

1 A transient vibration time-history testing calibration method comprising the steps of:

loading preliminary shaker instructions corresponding to a predetermined acceleration time history waveform;

producing dummy load initial calibrated shaker instructions by a dummy load attenuated shaking process in which shaking forces are applied to a dummy load at a first attenuated value of said preliminary shaker instructions;

providing dummy load final calibrated shaker instructions by performing a dummy load full strength shaking process in which shaking forces are applied to said dummy load at a full force value of said dummy load initial calibrated shaker instructions;

producing equipment under test (EUT) initial calibrated shaker instructions by performing an equipment under test (EUT) attenuated shaking process in which shaking forces are applied to equipment under test (EUT) at a second attenuated value of said dummy load final calibrated shaker instructions; and

performing a full force waveform test on said equipment under test (EUT) utilizing said equipment under test (EUT) initial calibrated shaker instructions.

2 The transient vibration time-history testing calibration method of claim 1 wherein said dummy load attenuated shaking process comprises the steps of:

shaking a dummy load at a first attenuated value of said preliminary shaker instructions;

measuring the actual acceleration time-history movement of said dummy load when shook at said attenuated value of said preliminary shaker instructions;

analyzing if said test response spectrum (TRS) is projected to be within a predetermined acceptable range of a required response spectrum (RRS);

utilizing a copy of said preliminary shaker instructions as said dummy load initial calibrated shaker instructions if said test response spectrum (TRS) is projected to be within an predetermined acceptable range of a required response spectrum (RRS); and

making adjustments in said preliminary shaker instructions to produce said dummy load initial calibrated shaker instructions if said test response spectrum (TRS) is not projected to be within an predetermined acceptable range of a required response spectrum (RRS), said adjustments

calculated to bring a said full strength test response spectrum (TRS) within an predetermined acceptable range of said required response spectrum (RRS).

3 The transient vibration time-history testing calibration method of claim 1 wherein said dummy load full strength shaking process comprises the steps of:

shaking a dummy load at full strength value of said dummy load initial calibrated shaker instructions;

measuring the actual acceleration time-history movement of said dummy load when shook at said full strength value of said dummy load initial calibrated shaker instructions;

determining if said test response spectrum (TRS) is within a predetermined acceptable range of said required response spectrum (RRS);

making adjustments in said dummy load initial calibrated shaker instructions to produce said dummy load final calibrated shaker instructions if said dummy load full strength test response spectrum TRS is not within a predetermined acceptable range of said required response spectrum (RRS) requirements, said adjustments calculated to bring a equipment under test full strength test response spectrum (TRS) within a predetermined acceptable range of said required response spectrum (RRS); and

utilizing a copy of said dummy load initial calibrated shaker instructions as said dummy load final calibrated shaker instructions if said dummy load full strength test response spectrum TRS is within an

predetermined acceptable range of said required response spectrum (RRS) requirements.

4 The transient vibration time-history testing calibration method of claim 1 wherein said equipment under test attenuated shaking process comprises the steps of:

shaking equipment under test at a second attenuated value of said dummy load final calibrated shaker instructions;

measuring the actual acceleration time-history movement of said equipment under test when shook at said attenuated value of said dummy load final calibrated shaker instructions;

analyzing if said test response spectrum (TRS) is within an predetermined acceptable range of said required response spectrum (RRS) requirements;

making adjustments in said dummy load final calibrated shaker instructions to produce said equipment under test attenuated shaker instructions if said dummy load full strength test response spectrum TRS is not within a predetermined acceptable range of said required response spectrum (RRS), said adjustments calculated to bring an equipment under test full strength test response spectrum (TRS) within an predetermined acceptable range of said required response spectrum (RRS); and

utilizing said dummy load final calibrated shaker instructions as said equipment under test attenuated calibrated shaker instructions if said

equipment under test attenuated strength test response spectrum TRS is within an predetermined acceptable range of said required response spectrum (RRS) requirements.

5 The transient vibration time-history testing calibration method of claim 1 wherein said equipment under test full strength process comprises the steps of:

shaking equipment under test at a full strength value of said equipment under test final calibrated shaker instructions;

measuring the actual acceleration time history movement of said equipment under test when shook at said full strength value of said predetermined waveform; and

determining if said equipment under test attenuated test response spectrum TRS is within a predetermined acceptable range of said required response spectrum (RRS) requirements.

6 The transient vibration time-history testing calibration method of claim 1 wherein said predetermined acceleration time history waveform is an acceleration-time history waveform VERTEQII as defined in Telcordia GR-63-CORE Issue 1 October 1995 Network Equipment-Building System (NEBS) requirements for physical protection environmental tests.

7 The transient vibration time-history testing calibration method of claim 1 wherein said first and said second attenuated values are between -2dB and -5dB.

8 The transient vibration time-history testing calibration method of claim 1 wherein said first and said second attenuated values are -3dB.

9 The transient vibration time-history testing calibration method of claim 1 wherein said predetermined range is said test response spectrum (TRS) above said required response spectrum (RRS) for frequencies at or above 1 Hz and no values are above by 30% or more between 1 Hz and 7 Hz.

10 The transient vibration time-history testing calibration method of claim 1 wherein said predetermined range is said test response spectrum (TRS) above said required response spectrum (RRS) for frequencies at or above 1 Hz and no values are above by 5% or more between 1 Hz and 7 Hz.

11 A transient vibration acceleration time-history testing method comprising the steps of:

performing an equipment under test (EUT) preparation process to ensure equipment under test (EUT) is ready for testing;

performing a transient vibration time history testing calibration method;

applying full level vibration simulation calibrated forces to said equipment under test (EUT) in accordance with the results of said calibration method; and

performing a post test inspection on said equipment under test (EUT).

12 A transient vibration acceleration time-history testing method of claim 11 wherein said equipment under test (EUT) preparation process comprises the steps of:

performing a testing level determination process that analyzes whether said equipment under test (EUT) is tested at a framework level or a shelf level;

performing a pretest configuration process that arranges said equipment under test (EUT) for testing in compliance with a particular utilization per an end-use installation; and

performing a pre-test inspection process that determines the pre-test condition of said equipment under test (EUT) including checking for structural and functional abnormalities or flaws before testing begins.

13 A transient vibration acceleration time-history testing method of claim 11 further comprising the steps of:

loading information associated with a predetermined acceleration time history waveform in a controller which produces shaker drive signals that control movements of a shaker;

running two waveform tests at a first attenuated value of said shaker drive signals on a dummy load with a similar mass and configuration to said equipment under test (EUT);

measuring the movements and acceleration of said dummy load;

making adjustments to update said drive signals if a projected test response spectrum (TRS) for the equipment under test is not within acceptable predetermined tolerances of a required response spectrum (RRS), said adjustments are projected to provide shaker drive signals that shake the equipment under test (EUT) within acceptable predetermined ranges of said required response spectrum (RRS);

running a waveform test at full strength on the dummy load and measuring movements of said dummy load

making additional adjustments in said shaker drive signals if said projected test response spectrum (TRS) for said equipment under test is still not within acceptable predetermined tolerances of said required response spectrum (RRS);

performing a waveform test on said equipment under test at a second attenuated value and measuring the movements of said equipment under test; and

making further adjustments in said shaker drive signals if said projected test response spectrum (TRS) for said equipment under test is still not within acceptable predetermined tolerances of said required response spectrum (RRS).

14 The transient vibration acceleration time-history testing method of claim 13 wherein said first attenuated value and said second attenuated value are -3 dB.

15 The transient vibration acceleration time-history testing method of claim 13 wherein said acceptable predetermined tolerances is a test response spectrum (TRS) above the required response spectrum (RRS) for frequencies at or above 1 Hz and no values are more than 30% above said required response spectrum (RRS) values between 1 and 7 Hz.

16 The transient vibration acceleration time-history testing method of claim 13 wherein said predetermined acceleration time history waveform is an acceleration-time history waveform VERTEQII as defined in Telcordia GR-63-CORE Issue 1 October 1995 Network Equipment-Building System (NEBS) requirements for physical protection environmental tests.

17 The transient vibration acceleration time-history testing method of claim 13 wherein said first attenuated value and said second attenuated value are between -2dB and -5dB.

18 An earthquake survivability testing method comprising the steps of:

loading shaker instructions including pre-stored drive pulse information;

running waveform tests on a dummy load including two waveform tests at a first attenuated value of said shaker instructions and making calibration adjustments to said shaker instructions, said calibration adjustments providing updated shaker instructions calculated to bring a measured test response spectrum (TRS) within an acceptable predetermined range of a required response spectrum (RRS);

running waveform tests on equipment under test including two waveform tests at a second attenuated value of said updated shaker instructions and making additional calibration adjustments to said updated shaker instructions, said additional calibration adjustments providing final calibrated shaker instructions calculated to bring a measured test response spectrum (TRS) within an acceptable predetermined range of a required response spectrum (RRS); and

performing a full level earthquake synthesized waveform test utilizing said final calibrated shaker instructions.

19 The earthquake survivability testing method of Claim 18 further comprising the step of hitting said equipment under test (EUT) with a -60 dB shaker driver signal based upon said final calibrated shaker instructions.

20 The earthquake survivability testing method of Claim 18 further comprising the steps of:

operating said equipment under test (EUT) off a vibration table using appropriate software or diagnostics at standard reference conditions;

assembling said equipment under test (EUT) with appropriate fixtures for testing per the product specific test assessment plan (TAP);

loading standard and approved test setups for a test equipment controller and loading of said standard and approved test setups is verified; and

performing a swept-sine survey of 0.2 g's from 1 to 50 Hz at 1.0 octave/minute and recording acceleration responses of the framework top and mid-point.

21 The earthquake survivability testing method of Claim 18 further comprising the steps of:

setting up appropriate camera views that capture the best observation of critical equipment under test (EUT) components and an associated digital server is checked to ensure it is recording;

monitoring the software and diagnostic functionality of the equipment under test (EUT)

analyzing potential errors between said test response spectrum (TRS) and said required response spectrum (RRS)

saving test data as a test report file including

22 The earthquake survivability testing method of Claim 21 further comprising wherein said test report includes relative displacement data (rack top minus rack bottom versus time) for an x and y axis, test response spectrum (TRS) information, acceleration data from the top of the frame, peak load cell data if taken and the post-test torque value of the fasteners, functionality data from the equipment under test (EUT), digital video with time-stamped frames of the framework earthquake synthesized waveform, and information on observations of post-test physical and functional performance inspection.

23 The earthquake survivability testing method of Claim 21 further comprising wherein said test report includes still images of the fixturing, frame mounting, equipment under test (EUT) mounting, weight distribution, and orientation of the framework and product to a test table.